I claim:

1. An optical PMD generator comprising:

a lens assembly for receiving a light beam from an input fiber and providing said light beam to an output fiber;

a beam-turning assembly for the redirection of the light beam from said input fiber to said output fiber; and

a variable PMD generating assembly located between said lens assembly and said beam-turning assembly, wherein said PMD generating assembly comprises:

a fixed DGD stage; and

a variable retardation stage.

2. The generator of claim 1 wherein said lens assembly is located at a first end of said generator and said turning assembly is located at a second end of said generator.

3. The generator of claim 2 wherein said variable PMD generating stage is located between said fixed stage and said turning assembly.

4. The generator of claim 1 wherein said turning assembly can reverse the direction of the beam an even number of times and said lens assembly comprises:

an input collimator at one end of the generator; and

an output collimator at another end of the generator.

5. The generator of claim 1 wherein said turning assembly can reverse the direction of the beam an odd number of times and said lens assembly comprises a two-fiber collimator.

6. The generator of claim 5 wherein said two-fiber collimator comprises dual-fiber collimator, wherein said dual-fiber collimator comprises a single lens, an input fiber, and an output fiber.

7. The generator of claim 1 wherein said lens assembly comprises:

a two-fiber collimator; and

a straightening prism between said collimator said variable PMD generating assembly, and wherein said straightening prism is positioned such that said beam, directly after passing through said straightening prism a first time, is substantially parallel to said beam, directly before passing through said straightening prism a second time.

8. The generator of claim 7 wherein said lens assembly further comprises a wedge prism located between said straightening prism and said variable PMD generating assembly.

9. The generator of claim 7 wherein said lens assembly further comprises a wedge prism located between said collimator and said straightening prism.

10. The generator of claim 1 wherein said lens assembly further comprises:

a support structure that holds said input fiber and said output fiber such that they are substantially parallel to each other; and

a lens array comprising

a first lens positioned at an end of said input fiber for collecting and collimating light emerging from said input fiber, and

a second lens positioned at an end of said output fiber for collecting and focusing light returning to the lens assembly.

11. The generator of claim 10 wherein said support structure holds said input and output fibers at a predetermined center-to-center spacing such that the focal planes of said input fiber and said output fiber are substantially coplanar.

12. The generator of claim 1 wherein said optical beam turning assembly comprises a turning element selected from a group consisting of a unitary turning prism, a retro-reflecting mirror, and a two-part prism.

13. The generator of claim 1 wherein said turning element provides a first amount of polarization retardation to an optical beam being turned by said element, and wherein said turning assembly further comprises a phase-compensating waveplate to substantially nullify the first amount of polarization retardation.

14. The generator of claim 13 wherein said second amount of polarization retardation is equal in magnitude to and opposite in direction from the first amount of retardation.

15. The generator of claim 13 wherein said phase-compensating waveplate comprises at least one compensator having an e-axis.

16. The generator of claim 15 wherein said turning element has a vertex axis and wherein said waveplate e-axis has an orientation with respect to said vertex axis selected from a group consisting of a substantially parallel orientation and a substantially perpendicular orientation.

17. The generator of claim 13 wherein said at least one element comprises a plurality of elements, each of said elements having an e-axis that has an orientation to prevent mode mixing as said beam travels from a first of said elements to a second of said elements.

18. The generator of claim 17 wherein any of said e-axes has an orientation with respect to any other of said e-axes selected from a group consisting of a substantially parallel orientation and a substantially perpendicular orientation.

19. The generator of claim 13 wherein said light beam has a wavelength and said second amount of

polarization retardation causes said turning assembly to add approximately an integral number of said wavelengths.

20. The generator of claim 1 wherein said turning element is a two-part prism that comprises a first prism part and a second prism part and has a vertex axis, wherein said turning assembly further comprising a mixing half wave waveplate located between said first and second prism parts, and wherein said waveplate has an e-axis orientation with respect to said vertex axis of about +45 degrees.

21. The generator of claim 1 wherein said fixed DGD stage comprises at least one passive birefringent element.

22. The generator of claim 21 wherein said beam has a direction within said at least one element and said at least one element is at least one birefringent element exhibiting a birefringence in a plane perpendicular to said direction.

23. The generator of claim 22 wherein said at least one birefringent element is cut so that the extraordinary crystalline axis is oriented substantially in said plane.

24. The generator of claim 21 wherein said at least one element comprises a plurality of birefringent elements, each of said birefringent elements having a birefringent axis that has an orientation to prevent mode

mixing as said beam travels from a first of said elements to a second of said elements.

25. The generator of claim 24 wherein any of said birefringent axes has an orientation with respect to any other of said birefringent axes selected from a group consisting of a substantially parallel orientation and substantially perpendicular orientation.

26. The generator of claim 25 wherein said turning assembly has a vertex axis and any of said birefringent axes has an orientation with respect to said vertex axis selected from a group consisting of a substantially parallel orientation and a substantially perpendicular orientation.

27. The generator of claim 26 further comprising a mixing half wave waveplate having an e-axis with an orientation with respect to said vertex axis selected from a group consisting of about +22.5 degrees, about -22.5 degrees, about +67.5 degrees, and about -67.5 degrees.

28. The generator of claim 21 wherein said at least one element comprises a material selected from a group consisting of yttrium ortho-vanadate, lithium niobate, rutile, calcite, alpha-barium borate, mica, crystalline quartz, and a combination thereof.

29. The generator of claim 21 wherein said at least one element comprises a combination of a first element having a first thermal expansion coefficient and a

second element having a second thermal expansion coefficient, each of said elements comprising at least one material, wherein said combination has a thermal expansion coefficient that is less than said first and second coefficients individually.

30. The generator of claim 29 wherein said first element comprises a first birefringent material having a first length and said second element comprises a second birefringent material having a second length, wherein said first and second lengths have a length ratio based on said first and second thermal coefficients.

31. The generator of claim 30 wherein said first element is comprises yttrium ortho-vanadate and said second element comprises lithium niobate.

32. The generator of claim 21 wherein said fixed DGD stage has an optical length and said at least one element comprises a plurality of birefringent elements, and wherein one of said plurality of birefringent elements comprises at least one auxiliary birefringent element having a birefringence that is relatively small compared with the other of said plurality of elements to fine-tune said optical length.

33. The generator of claim 32 wherein said auxiliary element comprises a crystalline quartz material.

34. The generator of claim 1 wherein said turning assembly has a vertex axis and said fixed DGD stage

has a birefringent axis that has an orientation of about 45 degrees with respect to said vertex axis.

35. The generator of claim 1 wherein said variable retardation stage comprises at least one electro-optic element constructed from an electro-optic material selected from a group consisting of lithium niobate, potassium titanium phosphate, rubidium titanium phosphate, rubidium titanium arsenate, lead zirconium lanthanum, and any combination thereof.

36. The generator of claim 35 wherein said beam has a direction within said at least one element and said at least one element exhibits a voltage-induced birefringence in a plane perpendicular to said direction.

37. The generator of claim 35 wherein said at least one electro-optic element comprises a plurality of electro-optic elements, each of said electro-optic elements having a p-axis that has an orientation to substantially prevent mode mixing as said beam travels from a first of said electro-optic elements to a second of said electro-optic elements.

38. The generator of claim 37 wherein any of said p-axes has a relative orientation with respect to any other of said p-axes selected from a group consisting of a substantially parallel orientation and a substantially perpendicular orientation.

39. The generator of claim 38 wherein said turning assembly has a vertex axis and any of said p-axes has an orientation with respect to said vertex axis selected from a group consisting of a substantially parallel orientation and a substantially perpendicular orientation.

40. The generator of claim 1 wherein said variable retardation stage comprises two groups of at least one electro-optic element having an anode and a cathode, each element having an intrinsic birefringence and a voltage-induced birefringence that occurs when a voltage is applied between said anode and said cathode, and wherein said groups are oriented such that said first group intrinsic birefringence cancels said second group intrinsic birefringence and said first group voltage-induced birefringence adds to said second group voltage-induced birefringence.

41. The generator of claim 40 wherein said variable retardation stage further comprises a mixing half-wave waveplate between said first group and said second group.

42. The generator of claim 40 wherein said first group has a voltage-induced birefringence major axis and said mixing half-wave waveplate has an e-axis, and wherein said first group e-axis has an orientation of about 45 degrees with respect to said major axis.

43. The generator of claim 40 wherein said first group at least one element and said second group at least one element are substantially the same and oriented in substantially the same directions, and said group voltages are applied in opposite directions.

44. The generator of claim 39 wherein a first group anode voltage is substantially the same as said second group cathode voltage and said first group cathode voltage is substantially the same as said second group anode voltage.

45. The generator of claim 1 wherein said variable retardation assembly further comprises a mixing half wave waveplate located between said fixed DGD stage and said variable retardation stage, wherein (1) said turning assembly has a vertex axis, (2) said variable retardation stage has a voltage-induced p-axis that has an orientation with respect to said vertex axis selected from a group consisting of a substantially parallel orientation and a substantially perpendicular orientation, (3) said fixed DGD stage has a birefringent axis that has an orientation with respect to said vertex axis selected from a group consisting of a substantially parallel orientation and a substantially perpendicular orientation, and (4) said mixing half-wave waveplate has an e-axis orientation with respect to said vertex axis selected from a group consisting of about +22.5 degrees, about -22.5 degrees, about +67.5 degrees, and about -67.5 degrees.

46. The generator of claim 1 wherein said turning assembly has a vertex axis and said fixed DGD stage has a birefringent axis having an orientation with respect to said vertex axis of about 45 degrees, and wherein said variable retardation stage has a voltage-induced birefringent axis having an orientation with respect to said vertex axis selected from a group consisting of a substantially parallel orientation and a substantially perpendicular orientation.

47. A method for generating PMD comprising:

adding a variable amount of retardation to said light beam, said variable amount of retardation comprising a first amount of retardation due to an intrinsic birefringence of a variable retardation stage and a second amount of retardation due to a voltage-induced birefringence of said variable retardation stage;

redirecting said light beam, through a turning assembly, back toward said variable retardation stage; and

further adding to said light beam, through said variable retardation stage, another first amount of retardation due to said intrinsic birefringence such that said two first amounts cancel, and another second amount of retardation due to said voltage-induced birefringence such that said two second amounts add.

48. The method of claim 47 further comprising:

adding, through a fixed DGD stage, a fixed amount of DGD to said light beam before said adding; and

adding, through said fixed DGD stage, a fixed amount of DGD to said light beam after said further adding.

49. The method of claim 48 wherein said fixed DGD stage comprises a plurality of crystals comprising at least two complimentary types of crystals, each type having a different temperature dependence, and wherein said adding a fixed amount of retardation and said adding the same fixed amount of retardation comprises adding complimentary amounts of retardation with said two types of crystals.

50. The method of claim 49 wherein said first and second types of crystals have a first and a second birefringence, respectively, and wherein said plurality of crystals further comprises a third type of crystal having a birefringence that is less than said first and second birefringences, wherein said adding a fixed amount of retardation and said adding the same fixed amount of retardation further comprises adding a predetermined differential amount of retardation when said light passes through said third type of crystal to ensure that said fixed amount is accurate.

51. The method of claim 47 wherein said turning assembly further comprises a phase-compensating waveplate along the optical path of said generator and said turning prism provides a first amount of polarization retardation to the optical beam, and wherein said method further comprises substantially nullifying the first amount of

polarization retardation by providing a second amount of polarization retardation.

52. The method of claim 51 wherein said second amount of polarization retardation is equal in magnitude to and opposite in direction from the first amount of retardation.

53. The method of claim 51 wherein said light beam has a wavelength and said second amount of polarization retardation causes said turning assembly to add approximately an integral number of said wavelengths.

54. A method for generating PMD using a device comprising a lens assembly for receiving a light beam from an input fiber and providing said light beam to an output fiber, a beam-turning assembly for redirecting the light beam from said input fiber to said output fiber, and a variable PMD generating assembly located between the lens assembly and the beam-turning assembly, wherein said PMD generating assembly comprises a fixed DGD stage and a variable retardation stage, said method comprising:

providing a light beam through said input fiber into said lens assembly;

directing said beam through said variable PMD generating assembly at least twice by folding the beam with said turning assembly, such that said light beam can undergo mode mixing; and

receiving said light beam through said output.

55. A PMD compensator comprising:

a polarization controller that can be optically coupled to an optical input fiber;

a PMD generator comprising a lens assembly for receiving a light beam from said input fiber and providing said light beam to an output fiber, a beam-turning assembly for redirecting the light beam from said input fiber to said output fiber, and a variable PMD generating assembly located between the lens assembly and the beam-turning assembly, wherein said PMD generating assembly comprises a fixed DGD stage and a variable retardation stage;

a receiver and error generator having an input optically coupled to an output of the PMD generator; and

a control signal generator having an input optically coupled to said receiver and error generator and an output coupled to the polarization controller and the PMD generator.